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CT4A AIRTRAINER - EVALUATION OF HANDLING CHARACTERISTICS WITH C--ETC(U)
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9 FLIGHT TEST REPORT

6 CT4A AIRTRAINER - EVALUATION OF HANDLING CHARACTERISTICS WITH CANOPY REMOVED

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AIRCRAFT RESEARCH AND DEVELOPMENT UNIT

TECHNICAL INVESTIGATION NO 554

CT4A AIRTRAINER - EVALUATION OF HANDLING CHARACTERISTICS WITH CANOPY REMOVED

SUMMARY

The flight characteristics of CT4A Airtrainer aircraft with the canopy removed were unknown. Flight trials were conducted to investigate and evaluate the aircraft handling with the canopy removed. Particular emphasis was placed on glide performance and the engine out landing situation.

C sub L General handling characteristics with the canopy removed were very similar to those with the canopy fitt[illegible] There was very little effect on aircraft C_L; the stalling speed ar[illegible]acteristics were very similar and the aircraft was reluctant to spin [illegible]craft C_D was markedly increased with the canopy removed. This was manifest as a noticeable lack of full power climb performance and a significant reduction in glide performance. Aircraft approach and flare speeds with power were unchanged. A ground glide ratio greater than 95% of the optimum could be achieved in the clean configuration at 80 KIAS in zero to 20 knot headwinds, at AUW's from 1900lb to 2400 lb with the engine windmilling and stopped. Glide performance was significantly better with the propeller stopped. C sub D

Best endurance glide with an adequate margin above the stall was obtained at 60 to 65 KIAS for the same AUW's with take-off flap extended.

The tests showed that engine out approach and landing should be at 80 KIAS using take-off flap.

LIST OF CONTENTS

CT4A AIRTRAINER - EVALUATION OF HANDLING CHARACTERISTICS WITH CANOPY REMOVED

References:

A. Technical Investigation 554, 2 April 1976

B. ARDU Report No TI 549, CT4A Airtrainer - Pressure Error Corrections, 30 September 1976

INTRODUCTION

1. Airtrainer aircraft could only be abandoned in flight by opening or jettisoning the canopy. Since the canopy was hinged at the rear the likelihood was that opening the canopy in flight would result in it being torn from the aircraft. In either case, there was a requirement to establish the handling characteristics and the safe airspeed margin necessary to recover or ditch the aircraft after the canopy was lost or jettisoned.

2. Aircraft Research and Development Unit (ARDU) was tasked by Reference A to investigate and evaluate the handling characteristics of CT4A Airtrainer aircraft with the canopy removed. Specific areas to be investigated were:

a. approach and flare speeds with power;

b. best glide speeds with propeller rotating and stationary; and

c. glide approach and flare speeds with propeller rotating and stationary.

3. Since only a limited performance evaluation of the aircraft had been completed on receipt of this task all the tests conducted with the canopy removed were repeated with the canopy fitted for comparison purposes.

CONDITIONS RELEVANT TO THE TEST

Test Aircraft

4. Airtrainer A19-031 was used for the tests. The aircraft skin was clean and aerodynamically representative of fleet aircraft except that the ARDU trials versions of Mods 7212.005.112 Part B (underwing vent) and 7212.005.120 (cooling air scoop) were fitted instead of the production versions.

5. The aircraft was weighed and centre-of-gravity determined. These are detailed in Table 1. The aircraft was flown with the same crew on all tests. A photograph of the test aircraft with the canopy removed is at Annex A.

Serial	Configuration a	Weight (lb) b	CG(inches aft of station datum)(1) c
1	No fuel, canopy fitted	1591.0	32.45
2	Full fuel, canopy fitted	1884.5	32.15
3	Full fuel, canopy removed	1843.0	31.75

NOTE: 1. CG limits: forward 30.2 inches
aft 36.0 inches

TABLE 1 - AIRCRAFT WEIGHT AND CG (A19-031)

Weather, Time and Place of Tests

6. Fourteen sorties were flown from Laverton for a total of 14.5 hours. Glide performance tests were flown in calm conditions with negligible thermal or orographic disturbances. Evaluation of minimal air disturbance was by the flight test observer who was an experienced sailplane instructor and included consideration of the atmospheric temperature lapse rate up to the test altitude.

Instrumentation

7. No special instrumentation was used except for a hand held stopwatch. The airspeed and engine RPM were recorded by the pilot in the left hand seat. The left hand ASI was calibrated at the beginning and end of the tests. Altitude was read by the flight test observer in the right hand seat (altimeter setting 1013 mb). The airspeed and altitude pressure error correction (PEC) used were determined under Reference B.

Glide Performance Test Technique

8. Glide performance was measured using the partial descent method, the time to descend 1000 feet being timed. The aircraft had maximum fuel at start-up and fuel added at the end of the flight was noted. The actual time at the beginning of each test point was noted and fuel state calculated by dividing the fuel used for all tests by the number of test points, taking into consideration that required for take-off/climb and recovery/landing. Engine RPM and indicated airspeed were recorded in the middle of each partial descent.

TESTS MADE

9. The following tests were made:

a. handling assessment canopy removed;

b. glide performance canopy fitted; and

c. glide performance canopy removed.

RESULTS OF TESTS

Handling Assessment Canopy Removed

10. Climb. The aircraft was climbed at full power at 80 to 85 KIAS. As with the standard aircraft and using a similar climb attitude, moderate difficulty was found in maintaining an accurate ($\pm$ 2 knot) airspeed. Climb performance was noticeably reduced above about 2000 feet altitude. In ISA conditions the rate of climb (ROC) was 300 feet/min at 5500 feet altitude. The absolute ceiling was estimated to be about 7000 feet altitude. A persistent, low frequency, low amplitude rudder buffet was evident during all manoeuvres at full power. This could be described as rudder tramp because of the low frequency (2Hz) but did not present any handling difficulties.

11. Stability and Control. The aircraft stability and control characteristics were examined in three typical configurations: cruise (clean, 2600 RPM, 100 KIAS level); approach (take-off flap, 85 KIAS, 500 feet/min ROD); and landing (full flap, 70 KIAS, 500 feet/min ROD).

a. Longitudinal. With the canopy removed the aircraft was easier to trim longitudinally in all three configurations than with the canopy fitted. The phugoid was more heavily damped (2 cycles) and the neutral band was smaller (about 10 knots) with a slightly higher stick force gradient. The aircraft was easy to manoeuvre in pitch.

b. Lateral and Directional. The rudder force gradient was constant and slightly higher with the canopy removed than with the standard aircraft. In the cruise configuration the level of airflow buffet (see para 14) increased markedly at about half rudder deflection (about 5^{o} sideslip) and caused some pilot discomfort at higher angles of sideslip. In both other configurations, full rudder could be applied in a steady heading sideslip with only slight pilot discomfort because of wind buffet. The dutch roll was heavily damped in all but the landing configuration when it was still damped more than with the standard aircraft. The roll component of the dutch roll was also more dominant than usual but no handling difficulties were experienced in the calm conditions in which the tests were conducted. Rates of roll in all configurations were qualitatively similar. The aircraft was slightly easier to trim directionally than usual.

12. Stalling. Stalling tests were conducted in several aircraft configurations. All stalls were in straight flight and were approached at less than 1 knot/second. Aircraft response to control inputs was checked at intervals throughout the approach to the stall. Post stall behaviour was examined by applying full back stick at the stall. In general, the stall was very similar to that of the standard aircraft in all the configurations tested except that there was decreased stall warning. There was no difficulty in aircraft control during the approach, the stall, post stall or recovery. All controls were effective throughout and there was no tendency to auto-rotation. The stall was always easily recognized. There was a slight decrease in lateral stability, especially in the full flap configuration (up to 10^{o} wing rock). This wing rock was easily controlled with aileron. The tests and the stalling configurations are detailed in Table 2 for an average AUW of 2208lb and CG position 31.6 inches aft of station datum.

/Serial

Serial	Configuration	Warning	Stall Speed (Canopy fitted)	Characteristics
1	Clean, idle power	61 KIAS	60 KIAS (60)	Nose drop
2	T/O flap,idle power	56½ KIAS	56 KIAS (55)	Nose and wing drop
3	Full flap,idle power	50 KIAS	50 KIAS (49½)	Wing and nose drop
4	Full flap,full power	-	47 KIAS	Nose drop from pronounced nose up attitude
5	Clean, propeller rotating 500 RPM	62 KIAS	62 KIAS (61½)	Nose drop, some tendency to wing drop - very dependent on sideslip
6	T/O flap,propeller	58 KIAS	58 KIAS (54½)	Greater tendency to wing drop
7.	Full flap, propeller stopped	52 KIAS	52 KIAS (49½)	Wing drop

TABLE 2 - STALLING TESTS - CANOPY REMOVED
CT4A A19-031 2208lb CG 31.6 INCHES

13. Circuit and Landing. Both normal and glide (idle power) circuits were flown. Handling during the normal circuit was similar to that with the canopy fitted except for the higher power settings required (eg 20 inches MAP as compared with 17 inches MAP, 100 KIAS, 1000 feet downwind). In calm conditions, a higher rate of descent (ROD) was evident on glide circuits but the normal pattern and speeds (100 KIAS, 1500 feet low key; 85 KIAS final) were suitable provided flap selection was delayed. For instance, T/O flap was selected about halfway around the base turn and full flap on short finals (cf para 32).

14. Pilot Comfort. For all of the test flights both the pilot and the flight test observer wore additional clothing and helicopter helmets (Type SPH4) fitted with oxygen masks from which the hoses had been removed. These equipments were used to facilitate communication. Cockpit noise level was markedly higher than with the canopy fitted but did not obstruct voice communication using the intercomm system. In flight there was a marked buffet within the cockpit (ie pressure variations) but this did not obstruct normal pilot operations. There was very little airlfow through the sides of the cockpit in balanced flight but a noticeable draught from rear to front between the pilots. This was sufficiently strong to 'whip' the pages of a checklist. Variation of sitting height had little effect in reducing noise or wind buffet. In cruising flight the slipstream could be felt (using a finger) to closely follow the contours of the canopy in the seating area of the cockpit back to at least the roll-over structure. There was no increase in noise or buffet at the stall. No flights were made using the standard helmet and boom microphone.

Glide Performance

15. Method of Calculation. The true rate-of-descent and angle of

/descent

descent were calculated using the time to glide through 1000 feet, the ambient air temperature at the pressure altitude of the test (from meteorological balloon flights) and the calibrated airspeed. From this the co-efficient of lift and drag for the test configuration was calculated for the aircraft AUW at the time of the test. The ratio of co-efficient of drag to co-efficient of lift was plotted against calibrated airspeed to give the best glide speed for that configuration (is minimum C_D/C_L). The aircraft drag co-efficient was assumed to be a function of the square of the aircraft lift co-efficient and a second order least squares fit of the test data was used to generate an equation of the form $C_D = C_{DE} + k_1 C_L^2 + k_2 C_L^4$ for each congifuration tested.

16. <u>Configurations and Drag Models</u>. The configurations tested are listed in Table 3. The results obtained are at Annex B, which details:

a. the constant co-efficient of the drag equation;

b. the range of C_L tested; and

c. the value of C_L for minimum C_D/C_L

for each configuration.

Serial	Canopy a	Power b	Flap Position c
1	On	Idle	Retracted
2	On	Propeller Windmilling	Retracted
3	On	Propeller Stopped	Retracted
4	Off	Idle	Retracted
5	Off	Idle	Take Off Flap
6	Off	Idle	Full Flap

<u>TABLE 3 - CONFIGURATIONS TESTED</u>

17. <u>Effect of Canopy</u>. Glide performance both with the canopy installed and removed is presented at Annex C for the engine at idle power and at sea level in ISA conditions. The reference weight with the canopy fitted was taken as 2250 lb and as 2208 lb with the canopy removed. The aircraft was slightly easier to trim longitudinally with the canopy removed than with the canopy fitted but in both cases little difficulty was experienced in maintaining airspeed within 2 knots in still conditions using the horizon as a visual reference. There was little pilot discomfort in terms of noise buffet or other distraction in a clean, idle power glide with the canopy removed.

18. <u>Effect of Engine</u>. Glide performance with the canopy fitted, the flaps retracted and at idle power, with the propeller windmilling (ie mixture control idle cut-off) and with the propeller stopped is at Annex D. The reference weight for these data was 2250 lb at sea level in ISA conditions. The propeller windmilling condition was established immediately following a full power climb to the test altitude (ie CHT 210 to 220°C) by retarding the throttle to idle, selecting idle cut-off with the mixture control and turning both the ignition and the low boost pump 'OFF'. The selected speed was established and

/held for

held for at least 500 feet prior to timing the descent over the next 1000 feet. By the end of the timed descent the CHT decayed to about 100°C. At airspeeds below about 70 knots there was a tendency for the propeller to slow and eventually stop particularly if two or more successive timed descents were attempted without an intervening climb. In a prolonged glide with the propeller windmilling when the propeller did stop completely a marked directional trim change was evident (~3° sideslip from the right at 70 KIAS). Some care was required to re-trim the aircraft in this situation because the yaw and out-of-trim condition was easily masked by the moderate engine vibration associated with the propeller slowing from 400 to 0 RPM.

19. Effect of Flap. Canopy off glide performance at idle power and in the clean, take-off flap and full flap configurations is graphically presented at Annex E. The reference weight for these data was 2208 lb at sea level in ISA conditions. The longitudinal and directional trim change on changing the flap position was not markedly different to that with the canopy fitted but, again, the aircraft was easier to trim with the canopy removed than with the canopy fitted (cf para 11). The other significant feature of aircraft handling in these tests was the noticeably high ROD and steeper nose-down (ND) attitude associated with a full flap glide with the canopy removed compared to that with the canopy fitted (20° ND compared with 15° ND at 85 KIAS).

DISCUSSION OF RESULTS

Handling Assessment - Canopy Removed

20. Climb. Aircraft handling qualities in a full power climb with the canopy removed were satisfactory. The noticeable lack of climb performance above about 5500 feet altitude in ISA conditions indicated that difficulties might be experienced in climbing to even moderate altitudes in hot conditions. This was unsatisfactory but acceptable since this aspect should not prevent recovery of an aircraft after jettisoning the canopy.

21. Stability and Control. The qualitative nature of the tests sufficed to indicate that the stick free longitudinal and directional static stability were increased with the canopy removed. For typical configurations, including propeller windmilling and propeller stopped glides, aircraft stability and control was satisfactory with the canopy removed.

22. Stalling. The stalling characteristics and post stall behaviour of the aircraft were satisfactory with the canopy removed. There was no tendency for the aircraft to auto-rotate even with full aileron deflection and this, together with the evidence of increased directional static stability indicated that the likelihood of an inadvertent spin was low. Although spinning tests were not conducted there was no reason to suspect that recovery from a fully developed spin would be prevented if the canopy was jettisoned. Since the stalling speeds were similar with the canopy fitted and removed, the deduction was that the canopy did not significantly contribute to the coefficient of lift at high angles of attack (see Table 2). All performance tests, however, showed that removing the canopy imposed a severe drag penalty (see paras 20 and 25). This resulted in a higher ROD at the stall than with the canopy fitted which, together with the (slightly) reduced stall warning was unsatisfactory but acceptable since the stall was easily identified and easily recoverable.

/23. Circuit

23. Circuit and Landing. The handling characteristics of the aircraft in the circuit and during approach and landing were satisfactory with the canopy removed in the event that engine power was available. Normal approach and flare speeds should be used in the situation with the proviso that engine power should be reduced slowly on landing because of the high aircraft drag with the canopy removed. A rapid reduction in power might allow the airspeed to reduce at a faster rate than (especially a student) pilot might anticipate, leading to a heavy landing or tail strike. This was unsatisfactory but acceptable for an emergency mode of operation. Engine out circuits and landing are discussed in para 33.

24. Pilot Comfort. Pilot comfort in the aircraft in all normal attitudes and configurations with the canopy removed was satisfactory. Although no flights were made using the standard helmet (Type HGU-2/P) and boom microphone the absence of significant airflow around the pilots' heads indicated that communication between pilots or to other stations should not be degraded. However, the marked air inflow in the clean configuration with sideslip might inhibit communication in a spin during which the canopy was jettisoned preparatory to abandoning the aircraft. In this case, the captain should instruct the other occupant of the intention to abandon the aircraft before the canopy was jettisoned. The intention to abandon the aircraft would be implicit in the action of jettisoning the canopy; the only foreseeable difficulty might arise if the captain changed his decision not to abandon the aircraft after jettison. This aspect was unsatisfactory but acceptable.

Glide Performance

25. Effect of Canopy. The tests showed a significant increase in aircraft drag at idle power with the canopy removed. The same effect would be evident in configurations not tested. The base drag (C_{DE}) was increased by 16% with the canopy removed and there was a further effect of increased induced drag (contributed by the terms $k_1 C_L^2$ and $k_2 C_L^4$ in the drag equation) of up to 9% at stalling speeds ($C_L = 1.32$) (see Annex B, serials 1 and 4).

26. Effect of Engine. The tests showed that in the case of engine failure where the propeller was windmilling the propeller was likely to eventually stop because of the engine cooling if sufficient height was available for a prolonged glide. This was desireable since the minimum drag condition was with the propeller stopped. Idle power closely approximated the propeller windmilling case since C_{DE} was slightly greater for the latter but induced drag effects were similar (ie k_1, k_2 similar value for idle and windmill; see Annex B, serials 1 and 2). Induced drag effects were also similar with the propeller stopped but the base (or zero lift) drag (C_{DE}) was significantly less (20%). Comparative still air glide ratios with the canopy fitted for idle, windmill and stopped were 7.56, 7.41 and 8.52 respectively. Again, the effect of power was applicable to configurations other than those tested.

27. Effect of Take-off Flap. Although the base drag with take-off flap increased over that for the clean aircraft (ie C_{DE} greater) at higher angles of attack ($C_L > \sim 1.2$), the total drag with take-off flap was less due to a smaller induced drag effect (ie k_1, k_2 less for take-off flap than for the clean configuration; see Annex B, serials 4 and 5). This was shown in Annex E where the plots of ROD for take-off flap and the clean configuration intersect at about 63 KCAS for a reference weight of 2208 lb in ISA sea level conditions.

/The same

The same effect would be present in other configurations not tested for instance, canopy fitted and propeller stopped. However, the slightly decreased ROD with flaps retracted would not normally be useful, particularly for a student pilot, because there was very little margin above the stall (cf Table 1, serial 1). If minimum ROD was required to minimize vertical impact energy the more appropriate action would be to glide using take-off flap, accepting a slightly greater ROD but maintaining a greater margin above the stall (cf Table 2, serial 2). This situation could arise for instance, in a night engine out landing in unknown terrain.

28. <u>Effect of Full Flap</u>. The effect of full flap was to significantly increase both C_{DE} and C_{L} max. Furthermore, induced drag was significantly increased with full flap (see Annex B, serial 6). The tests allowed direct comparison at idle power but, again, the effect would be evident in configurations not tested.

Glide Speed Compromise

29. <u>Utilization of Results</u>. Although the tests provided precise quantitative data on the effect of canopy, power and flap on glide performance, there were two other major variables which should be considered. These were aircraft AUW and wind. The airspeed for best glide angle for AUW's other than those for which the results were presented could be easily calculated since it was proportional to the square root of AUW:

$$\text{ie} \quad \frac{\text{KCAS reqd}}{\text{KCAS test}} = \sqrt{\frac{\text{AUW reqd}}{\text{AUW test}}} \quad \text{(for best glide angle)}$$

The effect of wind on best ground glide angle could be determined either analytically or graphically since wind moved the ordinate axis of the graph of ROD against KCAS along the abscissa according to the direction of the wind. For instance, in the case of a headwind, the origin was moved to the right by the strength of the headwind as illustrated in Figure 1.

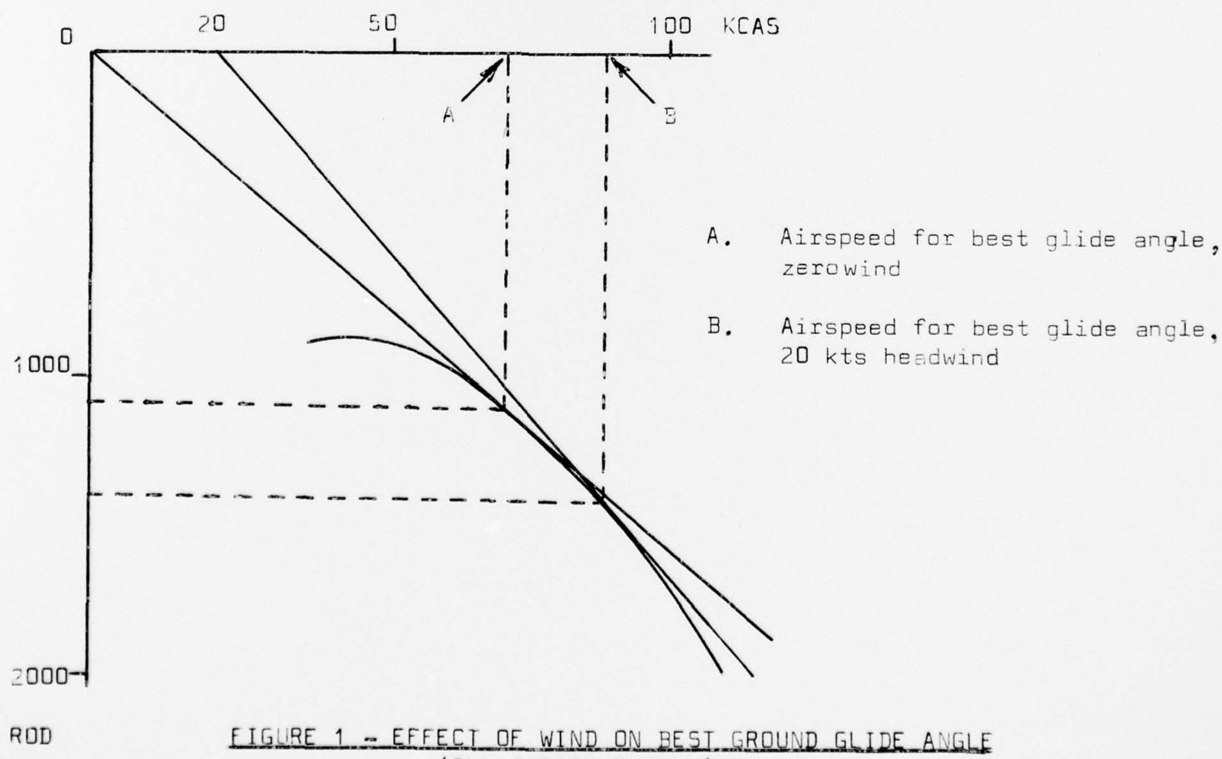

FIGURE 1 - EFFECT OF WIND ON BEST GROUND GLIDE ANGLE (ILLUSTRATIVE ONLY)

30. Effect of AUW and Headwind on Glide Performance (Canopy On/Clean). To reduce the test data to a single compromise airspeed for best glide angle in the clean configuration taking into account AUW and headwind, the criterion adopted was that a ground glide ratio greater than 95% of the optimum should be achieved in headwinds up to 20 knots. Using the method outlined in para 30 and Annex D, the results detailed in Table 4 were obtained:

Serial	Power	Condition	Optimum		95% Optimum	
	a	b	KCAS c	Ground Glide Ratio d	KCAS e	Ground Glide Ratio f
1	Prop Stopped	Still air	83	8.52	72 until prop turns	8.10
2		20 kt headwind	90	6.52	76 until prop turns	6.20
3	Idle	Still air	79	7.56	68 to 92	7.18
4	Power	20 kt headwind	85	5.69	74 to 98	5.41
5	Prop	Still air	77.5	7.41	Prop stop to 90.5	7.04
6	Windmill	20 kt headwind	84	5.50	71 to 99	5.23

TABLE 4 - EFFECT OF 20KT HEADWIND ON BEST GLIDE ANGLE
(CT4A A19-031 AUW 2250LB)

To maintain >95% optimum ground glide ratio at an AUW of 2250 lbs in headwinds from 0 to 20 knots the speed range was 76 KCAS to 90.5 KCAS (Serials 2e and 5e of Table 4). Adjusting those values for AUW from 2400lb to 1900 lb (see para 30) these airspeeds became, for equal glide angles:

a. 76 KCAS at 2250 lb to 78.5 KCAS at 2400 lbs; and

b. 90.5 KCAS at 2250 lb to 83 KCAS at 1900 lbs.

Therefore, the airspeed range for > 95% optimum ground glide ratio for headwinds from 0 to 20 knots and AUW's from 2400 lb to 1900 lb was 78.5 KCAS to 83 KCAS. To provide an easily remembered round figure a compromise airspeed of 81.5 KCAS (80 KCAS) was chosen.

31. Analysis of Glides at 81.5 KCAS (80 KIAS). Using the method of para 30 the information presented in Table 5 was extracted from Annex D for clean glide performance with the canopy fitted in headwinds up to 20 knots and for AUW's from 1900 to 2400 lb. This showed that 81.5 KCAS (80 KIAS) gave greater than 96% of the optimum glide angle for these conditions (Serial 5e of Table 5). An adequate rule-of-thumb for pilot estimation of gliding range was one nautical mile/1000 feet height. For headwinds of 40 knots, the optimum gliding speed increased to 95 KCAS but flight at 81.5 KCAS provided greater than 93% optimum ground glide ratio. The situation in any headwind/AUW combination would be marginally improved if the propeller was stopped since the worst case of idle power was used as the basis for comparison.

Serial	Power	AUW	Nil Wind			20 knot Headwind		
			Optimum Glide Ratio	81.5 KCAS Glide Ratio	% Optimum	Optimum Glide Ratio	81.5 KCAS Glide Ratio	% Optimum
	a	b	c	d	e	f	g	h
1	Prop Stopped	1900	8.52	8.47	99%	6.52	6.36	97%
2		2400	8.52	8.47	99%	6.52	6.36	97%
3	Idle	1900	7.56	7.37	97%	5.69	5.52	97%
4	Power	2400	7.56	7.56	100%	5.69	5.68	100%
5	Prop	1900	7.41	7.16	96%	5.50	5.35	97%
6	Windmill	2400	7.41	7.39	100%	5.50	5.50	100%

TABLE 5 - ANALYSIS OF GLIDES AT 81.5 KCAS (80 KIAS)
(CT4A A19-031, CLEAN CONFIGURATION, CANOPY FITTED)

32. Effect of Canopy on Compromise Airspeed. The flight test data obtained permitted comparison between canopy fitted and removed only at idle power. However, this was the worst situation (see Annex D) with respect to ROD and glide ratio. Any other engine condition could be expected to give smaller values of ROD and larger values of glide ratio. A comparison of the canopy fitted and canopy removed gliding performance at idle power at an AUW of 2208lb (derived from 2250lb less the weight of the canopy) for 0 to 20 knot headwind conditions is at Table 6. Examination of Table 6 showed that the airspeed for the optimum glide ratio was within normal flying accuracy of the compromise air speed of 81.5 KCAS (80 KIAS). Further comparison showed that gliding flight at 81.5 KCAS would give greater than 95% of the optimum glide ratio for all engine conditions in headwinds from 0 to 20 knots.

Serial	Canopy	Optimum Nil Wind		Optimum 20 knot Headwind	
	a	Airspeed b	Glide Ratio c	Airspeed d	Glide Ratio e
1	ON	76 KCAS	7.56	85 KCAS	5.69
2	OFF	78 KCAS	6.99	82 KCAS	5.18

TABLE 6 - EFFECT OF CANOPY ON COMPROMISE AIRSPEED
(CT4A A19-031, CLEAN CONFIGURATION, IDLE POWER)

33. Approach and Flare at 80 KIAS. The discussion at para 29 of the effect of full flap was based on the airspeed for best glide angle (minimum C_D/C_L). At an AUW of 2208 lb in nil wind conditions with the canopy removed this airspeed was about 70 KCAS (70 KIAS) with a ROD of 1275ft/min and a ground glide angle of 10.4 degrees. The rapid decay in airspeed caused by the significant rise in induced drag as the aircraft was flared to arrest the ROD for landing did not allow sufficient margin for error

/if this

if this manoeuvre was begun from 70 KIAS. This was due to the steep nose down (ND) attitude required to maintain airspeed with full flap selected. On the other hand, maintaining 80 KIAS with full flap, while increasing the margin for (particularly student) pilot error as far as airspeed was concerned, increased the ND attitude and the ROD (to about 1550 ft/min)(see Annex E). The increased change in pitch attitude required to arrest this ROD could well nullify the benefit of the higher airspeed because of the tendency to over-pitch the aircraft leading to a balloning effect with the airspeed rapidly decreasing and the aircraft several feet above the ground. Any headwind would further aggravate this situation which could result in a heavy landing or in the worst situation, a stall and loss of control. This was unsatisfactory for student pilot operations. To overcome this situation the forced landing procedure should be to use take-off flap for landing. Full flap should only be used for glide path control in a gross overshoot situation.

CONCLUSIONS

34. Handling Assessment. The flying qualities of the CT4A Airtrainer with the canopy removed were generally satisfactory (para 20). The stalling characteristics were satisfactory with no tendency to autorotation if the aircraft was mishandled at the stall (para 22). Aircraft performance was noticeably degraded with the canopy removed but this should not prevent safe recovery (para 20). Pilot comfort was adequate and no difficulty in communications was anticipated (para 24).

35. Glide Performance. Glide performance was significantly reduced with the canopy removed (paras 25,27,28). Best glide performance was achieved with the engine stopped (para 26). The airspeed for glide angles greater than 95% of optimum was 80 KIAS for the following conditions (paras 29 to 32):

a. canopy fitted or removed;

b. 1900 lb to 2400 lb AUW;

c. nil wind to 20 knots headwind;

d. engine idling/windmilling/stopped; and

e. flaps retracted.

Similarly, best endurance glide performance was obtained at about 60 to 65 KIAS with take-off flap selected (para 28). Engine out approach and landing should be made at 80 KIAS using take-off flap as required on final. Full flap should not be used except for glide path control in a gross overshoot situation (para 34).

DETAIL

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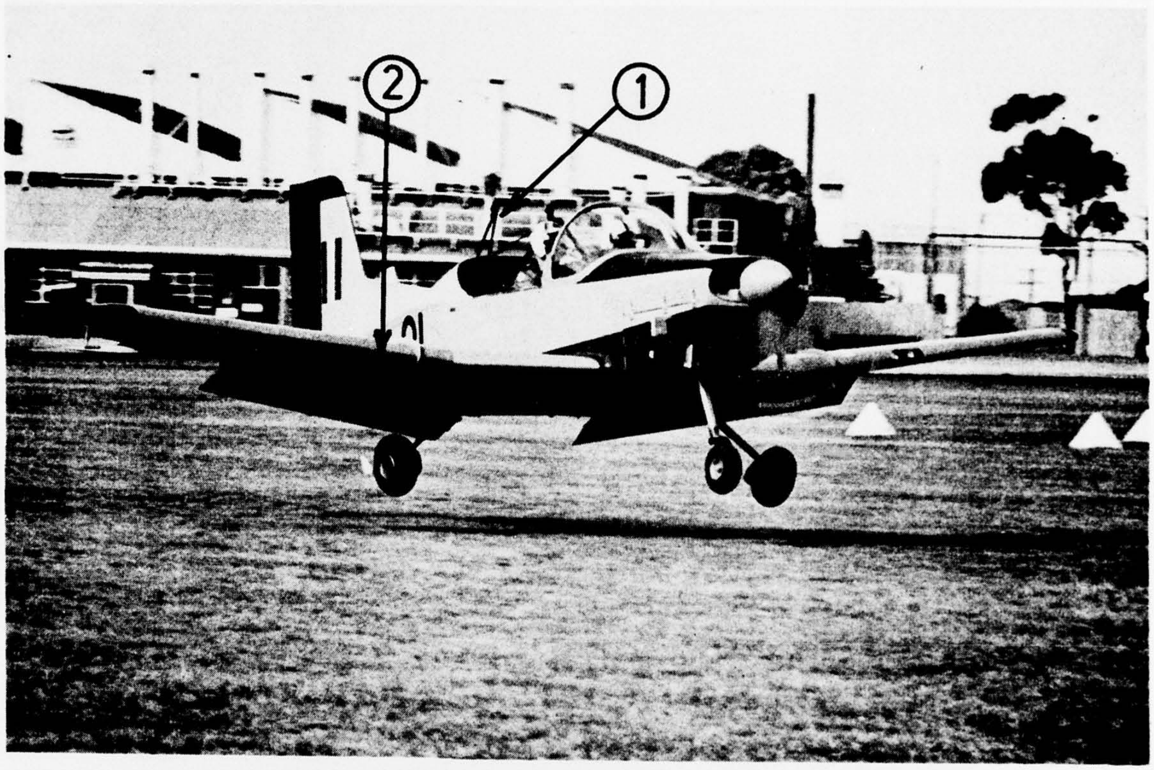
Report No	:	TI 554
HQSC File No	:	3000/7/1-554
ARDU File No	:	2535/2/554/Tech

PHOTOGRAPH OF TEST AIRCRAFT A19-031



1. Canopy Hinges and Brackets

2. Under Wing Tank Vents

DRAG EQUATION CO-EFFICIENTS AND MINIMUM DRAG C_L

Drag equation $C_D = C_{DE} + k_1 C_L^2 + k_2 C_L^4$

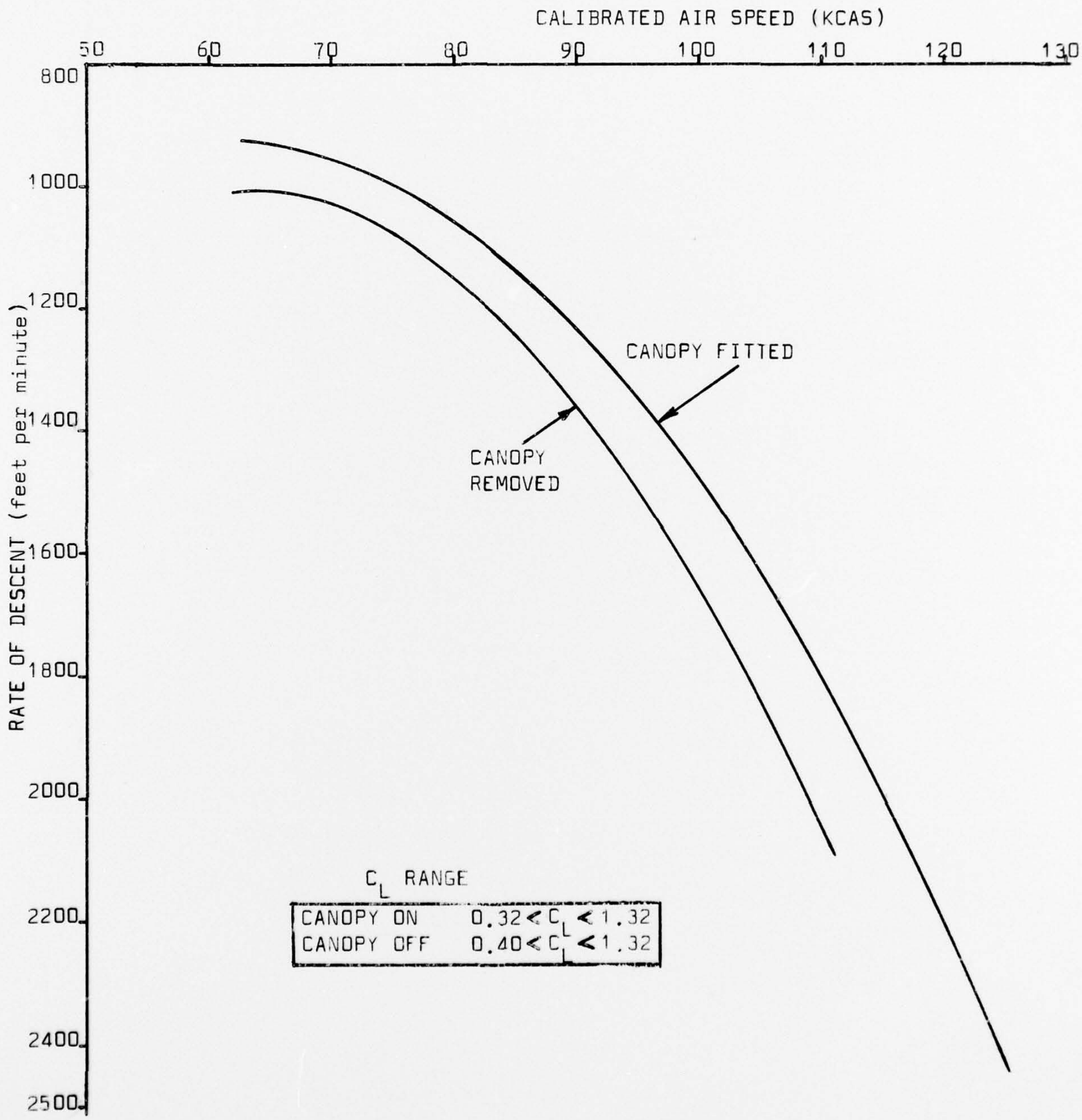
Wing reference area 129 ft^2

S/No	Configuration a	C_{DE} b	k_1 c	k_2 d	Range of C_L e	C_L for min CD/C_L f
1	Canopy on, Clean Idle Power	5.47×10^{-2}	7.72×10^{-2}	2.43×10^{-3}	0.32 to 1.32	0.82
2	Canopy on, Clean Prop Windmill	5.49×10^{-2}	8.58×10^{-2}	-4.63×10^{-3}	0.32 to 1.00	0.85(1)
3	Canopy off, Clean Idle Power	4.35×10^{-2}	7.66×10^{-2}	3.30×10^{-3}	0.56 to 1.32	0.73(2)
4	Canopy off, Clean Idle Power	6.33×10^{-2}	7.41×10^{-2}	8.19×10^{-3}	0.40 to 1.32	0.83
5	Canopy off, T/O Flap, Idle Power	7.63×10^{-2}	7.09×10^{-2}	4.67×10^{-3}	0.64 to 1.64	0.95
6	Canopy off, Full Flap, Idle Power	9.05×10^{-2}	9.22×10^{-2}	-1.24×10^{-3}	0.68 to 2.10	1.01

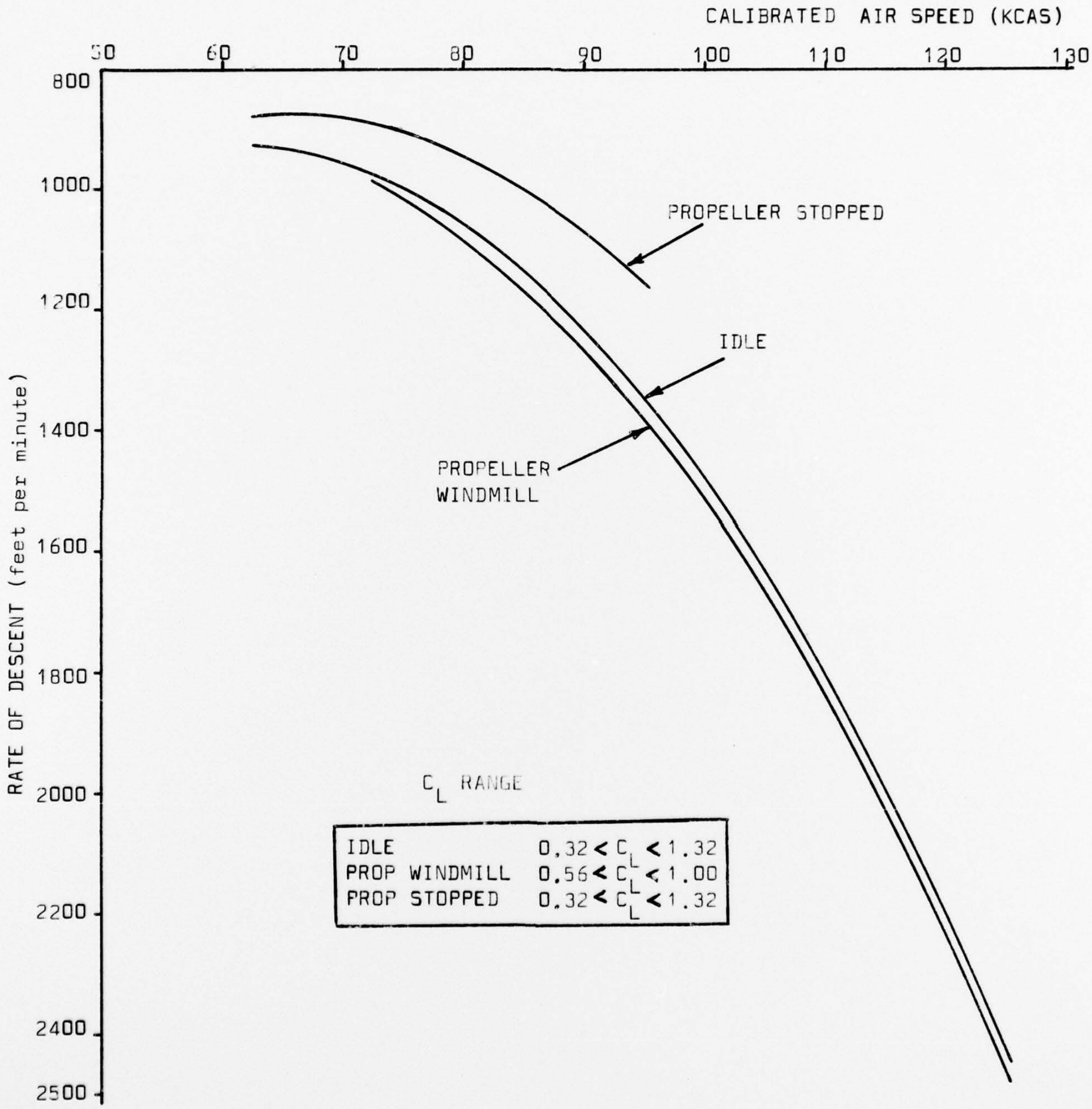
NOTES:

1. Prop tended to stop for $1.00 < C_L < 1.32$
2. Prop started to turn above 95 KCAS ($C_L \sim 0.56$)

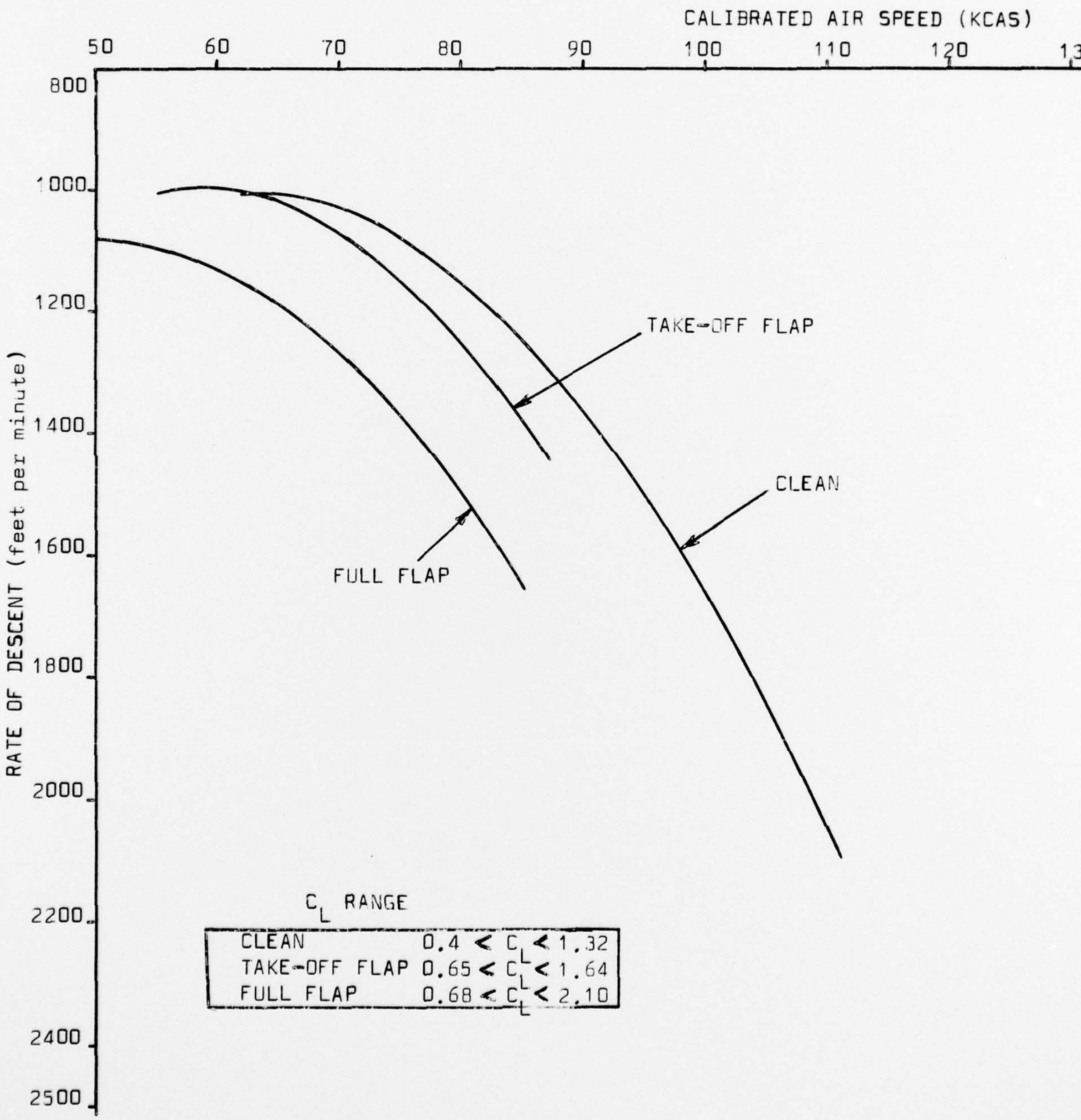
EFFECT OF FLAP ON GLIDE PERFORMANCE
CT4A A19-031-CLEAN CONFIGURATION-IDLE POWER
CANOPY ON-AUW 2250 LB - CANOPY OFF-AUW 2208



EFFECT OF ENGINE ON GLIDE PERFORMANCE
CT4A A19-031-AUW 2250 LB
CANOPY FITTED-CLEAN CONFIGURATION



EFFECT OF FLAP ON GLIDE PERFORMANCE
CT4A A19-031-AUW 2208 LB
CANOPY REMOVED-IDLE POWER



C_L RANGE

CLEAN	$0.4 < C_L < 1.32$
TAKE-OFF FLAP	$0.65 < C_L < 1.64$
FULL FLAP	$0.68 < C_L < 2.10$

AIRCRAFT RESEARCH AND DEVELOPMENT UNIT

TECHNICAL INVESTIGATION NO 554

CT4A AIRTRAINER - EVALUATION OF HANDLING CHARACTERISTICS WITH CANOPY REMOVED

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